

CLAIMS

What is claimed is:

1. A position determination system, comprising:
 - a first measuring module, including
 - a first sensing device for obtaining positional data of a first testing target relative to the first sensing device;
 - a calibration sensing device rigidly linked to the first sensing device, wherein the positional relationship between the first sensing device and the calibration sensing device is known; and
 - a first rotation mechanism for rotating the first sensing device without altering the positional relationship between the first sensing device and the calibration sensing device;
 - a second measuring module, including
 - a second sensing device for obtaining positional data of a second testing target relative to the second sensing device;
 - a calibration target for use with the calibration sensing device to obtain positional data of the calibration target relative to the calibration sensing device, wherein the calibration target is rigidly linked to the second sensing device, and the positional relationship between the second sensing device and the calibration target is known; and

a second rotation mechanism for rotating the second sensing device without altering the positional relationship between the second sensing device and the calibration target;

and

a data processing system coupled to the first and second measuring modules and configured to provide a user interface indicating positions of the first sensing device and the second sensing device.

2. The system of claim 1, wherein the data processing system is configured for carrying out the machine-implemented steps of:
 - receiving information related to a positional relationship between the first testing target and the first sensing device;
 - receiving information related to a positional relationship between the second testing target and the second sensing device;
 - receiving information related to a positional relationship between the calibration target and the calibration sensing device; and
 - determining a positional parameter of the first testing target and a positional parameter of the second testing target based on the positional relationship between the first sensing device and the calibration target, the positional relationship between the second sensing device and the calibration sensing device, the positional relationship between the first testing target and the first sensing device, the positional relationship between the second testing target and the first sensing device,

target and the second sensing device, and positional relationship between the calibration target and the calibration sensing device.

3. The system of claim 1, wherein the first sensing device, the second sensing device and the calibration sensing device are machine vision devices.
4. The system of claim 3, wherein the machine vision devices are cameras.
5. The system of claim 1, wherein the first testing target, the second testing target and the calibration target include light emitting sources.
6. The system of claim 5, wherein the first sensing device, the second sensing device and the calibration sensing device are light sensors.
7. The system of claim 1, wherein the first measuring module further includes a first supporting structure to which the first sensing device and the calibration target attach, and the second measuring module includes a second supporting structure to which the second sensing device and the calibration sensing device attach.
8. The system of claim 7, wherein the first supporting structure is rotatable relative to a first pivot axis, and the second supporting structure is rotatable relative to a second pivot axis.

9. The system of claim 8, wherein the first sensing device and the calibration sensing device move with the first supporting structure when the first supporting structure rotates relative to the first pivot axis; and the second sensing device and the calibration target move with the second supporting structure when the second supporting structure rotates relative to the second pivot axis.

10. The system of claim 8, wherein the first rotation mechanism includes a first motor for rotating the first supporting structure relative to the first pivot axis, and the second rotation mechanism includes a second motor for rotating the second supporting structure relative to the second pivot axis.

11. The system of claim 1, wherein the data processing system is configured to carry out the machine-implemented steps of:

receiving information related to a positional relationship between the calibration target and the calibration sensing device;

accessing reference data; and

indicating the positions of the first sensing device and the second sensing device based on the positional relationship between the calibration target and the calibration sensing device, and the reference data.

12. The system of claim 11, wherein the reference data is related to the positional relationships between the calibration target and the calibration sensing device when the

first sensing device and the second sensing device are respectively positioned to at least two discrete positions.

13. The system of claim 12, wherein the reference data is generated based on data obtained by measuring less than all possible positional relationships between the calibration target and the calibration sensing device when the first sensing device and the second sensing device are respectively positioned to at least two discrete positions.

14. A data processing system for use with a position determination system that comprises a first measuring module and a second measuring module, the first measuring module including a first sensing device for obtaining positional data of a first testing target relative to the first sensing device; a calibration sensing device rigidly linked to the first sensing device, wherein the positional relationship between the first sensing device and the calibration sensing device is known; and a first rotation mechanism for rotating the first sensing device without altering the positional relationship between the first sensing device and the calibration sensing device; the second measuring module including a second sensing device for obtaining positional data of a second testing target relative the second sensing device; a calibration target for use with the calibration sensing device to obtain positional data of the calibration target relative to the calibration sensing device, wherein the calibration target is rigidly linked to the second sensing device, and the positional relationship between the second sensing device and the calibration target is known; and a second rotation mechanism for rotating the second sensing device without

altering the positional relationship between the second sensing device and the calibration target, the data processing system comprising:

a data processor;

a data storage device;

a display;

a communication port configured to couple to the first measurement module and the second measurement module; and

a data path coupled to the data processor, the data storage means the display, and the communication port;

wherein the data storage device bears instructions to cause the system upon execution of the instructions by the processor to perform the steps of:

generating reference data related to the positional relationships between the calibration target and the calibration sensing device when the first sensing device and the second sensing device are respectively positioned to at least two discrete positions, wherein the reference data is generated based on data obtained by measuring less than all positional relationships between the calibration target of the calibration sensing device when the first sensing device and the second sensing device are respectively positioned to the at least two discrete positions;

storing the reference data in the data storage device;

receiving signals related to a current positional relationship between the calibration target of the calibration sensing device; and

indicating current positions of the first sensing device and the second sensing device based on the current positional relationship between the calibration target of the calibration sensing device, and the reference data.

15. A machine-readable medium bearing instructions for controlling the operation of a position determination system that comprises a data processing system, a first measuring module and a second measuring module, both of which are coupled to the data processing system, the first measuring module including a first sensing device for obtaining positional data of a first testing target relative to the first sensing device; a calibration sensing device rigidly linked to the first sensing device, wherein the positional relationship between the first sensing device and the calibration sensing device is known; and a first rotation mechanism for rotating the first sensing device; the second measuring module including a second sensing device for obtaining positional data of a second testing target relative to the second sensing device; a calibration target for use with the calibration sensing device to obtain positional data of the calibration target relative to the calibration sensing device, wherein the calibration target is rigidly linked to the second sensing device, and the positional relationship between the second sensing device and the calibration target is known; and a second rotation mechanism for rotating the second sensing device, the machine-readable medium comprising instructions for controlling the position determination system to perform the steps of:

generating reference data related to the positional relationships between the calibration target and the calibration sensing device when the first sensing device and the second sensing device being respectively positioned to at

'least two discrete positions, the reference data being generated based on data obtained by measuring less than all possible positional relationships between the calibration target and the calibration sensing device when the first sensing device and the second sensing device being respectively positioned to the at least two discrete positions; and storing the reference data.

16. The machine-readable medium of claim 15 further comprising instructions for controlling the position determination system to perform the steps of:
 - receiving signals related to a current positional relationship between the calibration target and the calibration sensing device; and
 - indicating current positions of the first sensing device and the second sensing device based on the current positional relationship between the calibration target and the calibration sensing device, and the reference data.
17. A machine-readable medium bearing instructions for controlling the operation of a position determination system that comprises a data processing system, a first measuring module and a second measuring module, both of which are coupled to the data processing system, the first measuring module including a first sensing device for obtaining positional data of a first testing target relative to the first sensing device; a calibration sensing device rigidly linked to the first sensing device, wherein the positional relationship between the first sensing device and the calibration sensing device is known; and a first rotation mechanism for rotating the first sensing device between a large

position, a medium position, and a small position; the second measuring module including a second sensing device for obtaining positional data of a second testing target relative to the second sensing device; a calibration target for use with the calibration sensing device to obtain positional relationships between the calibration target and the calibration sensing device, wherein the calibration target is rigidly linked to the second sensing device, and the positional relationship between the second sensing device and the calibration target is known; and a second rotation mechanism for rotating the second sensing device between a large position, a medium position, and a small position, the machine-readable medium comprising instructions for controlling the position determination system to perform the steps of:

measuring two sets of positional relationship between the calibration target and the calibration sensing device when (1) the first sensing device being positioned at the large position and the second sensing device being positioned at the large position; and (2) the first sensing device being positioned at the small position and the second sensing device being positioned at the small position;

obtaining three sets of positional relationship between the calibration target and the calibration sensing device, wherein at least one of the three sets of positional relationship is selected from the positional relationships between the calibration target and the calibration sensing device when the first sensing device is positioned at the medium position and the second sensing device is positioned at any of the positions, the three sets of positional relationship are obtained by the steps of:

selectively measuring a first set of positional relationship between the calibration target and the calibration sensing device when (1) the first sensing device being positioned at the small position and the second sensing device being positioned at the medium position or the large position; or 2) the first sensing device being positioned at the small position and the second sensing device being positioned at the medium position;

selectively measuring a second set of positional relationship between the calibration target and the calibration sensing device when (1) the first sensing device being positioned at the large position and the second sensing device being positioned at the small position; 2) the first sensing device being positioned at the small position and the second sensing device being positioned at the large position; or (3) the first sensing device being positioned at the medium position and the second sensing device being positioned at the medium position; and

selectively measuring a third set of positional relationship between the calibration target and the calibration sensing device when (1) the first sensing device being positioned at the large position and the second sensing device being positioned at the medium position; or 2) the first sensing device being positioned at the medium position and the second sensing device being positioned at the large position;

generating reference data related to positional relationships between the calibration target and the calibration sensing device when the first sensing device and the second sensing device being respectively positioned to one of the positions based on the five sets of positional relationships between the calibration target and the calibration sensing device; and storing the reference data.

18. The machine-readable medium of claim 17, further comprising instructions for controlling the position determination system to perform the steps of:
 - receiving signals related to a current positional relationship between the calibration target and the calibration sensing device; and
 - indicating current positions of the first sensing device and the second sensing device based on the current positional relationship between the calibration target and the calibration sensing device, and the reference data.
19. A machine-readable medium bearing instructions for controlling the operation of a position determination system that comprises a data processing system, a first measuring module and a second measuring module, both of which are coupled to the data processing system, the first measuring module including a first sensing device for obtaining positional data of a first testing target relative to the first sensing device; a calibration sensing device rigidly linked to the first sensing device, wherein the positional relationship between the first sensing device and the calibration sensing device is known; and a first rotation mechanism for rotating the first sensing device; the second measuring

module including a second sensing device for obtaining positional data of a second testing target relative to the second sensing device; a calibration target for use with the calibration sensing device to obtain positional data of the calibration target relative to the calibration sensing device, wherein the calibration target is rigidly linked to the second sensing device, and the positional relationship between the second sensing device and the calibration target is known; and a second rotation mechanism for rotating the second sensing device, the machine-readable medium comprising instructions for controlling the position determination system to perform the steps of:

obtaining reference data related to the positional relationships between the calibration target and the calibration sensing device when the first sensing device and the second sensing device being respectively positioned to n discrete positions (n is a natural number no less than 2) by the steps of:
measuring $(2n-1)$ sets of all possible positional relationships between the calibration target and the calibration sensing device when the first sensing device and the second sensing device being respectively positioned to the n discrete positions; and
generating the reference data based on the $(2n-1)$ sets of positional relationships;

and

storing the reference data.

20. The machine-readable medium of claim 19, further comprising instructions for controlling the position determination system to perform the steps of:

receiving signals related to a current positional relationship between the calibration target and the calibration sensing device; and indicating current positions of the first sensing device and the second sensing device based on the current positional relationship between the calibration target and the calibration sensing device, and the reference data.

21. A position determination system, comprising:
 - a first measuring module, including
 - a first sensing means for obtaining positional data of a first testing target relative to the first sensing device;
 - a calibration sensing means rigidly linked to the first sensing device, wherein the positional relationship between the first sensing device and the calibration sensing device is known; and
 - a first rotation means for rotating the first sensing device without altering the positional relationship between the first sensing device and the calibration sensing device;
 - a second measuring module, including
 - a second sensing means for obtaining positional data of a second testing target relative to the second sensing device;
 - a calibration target for use with the calibration sensing means for obtaining positional data of the calibration target relative to the calibration sensing means, wherein the calibration target is rigidly linked to the second sensing device, and the positional relationship

between the second sensing means and the calibration target is known; and

a second rotation means for rotating the second sensing device without altering the positional relationship between the second sensing device and the calibration target;

and

a data processing system coupled to the first and second measuring modules and configured to provide a user interface indicating positions of the first sensing device and the second sensing device.